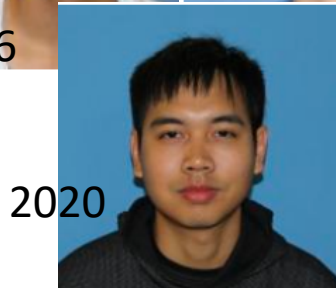


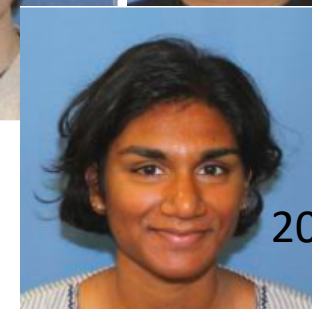
# AE63 – [PHY542]

## Advanced Accelerator Lab

by Mikhail Fedurin  
and Dmitry Kayran



December 7, 2020  
ATF User Meeting



# Goals of the course

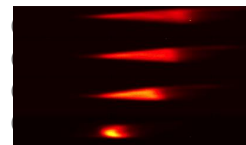
- Introduce students to the field of experimental Accelerator Physics
- Demonstrate e-beam techniques and diagnostics used in Advanced Accelerator Concept experiments at Accelerator Test Facility
- Teach students to model experiments, compare model results with measurements.

Advanced Accelerator Laboratory at Accelerator Test Facility (ATF), BNL, Spring 2015

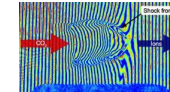
Course: PHY 542



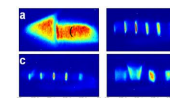
Experimental Demonstration of a Tunable De-chirper



Ion acceleration using laser driven shocks



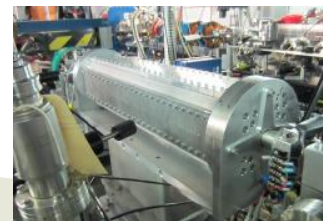
Beam Manipulation by Self-Wakefield



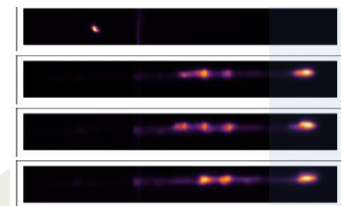
Topics covered:

- Design of accelerators and theoretical models
- Beam diagnostics
- Computational techniques
- High-brightness sources
- Novel ways of acceleration

“The ATF is a perfect place to learn how to deal with 21<sup>st</sup> century accelerators. You would have hands-on experience with modern accelerators and will learn how to tune and operate it”



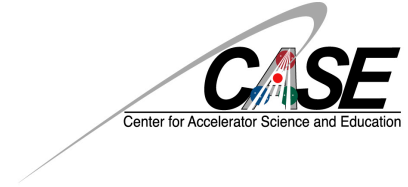
3 Credits!  
Register Now!



Contact Information:  
Prof. Mikhail Fedurin (fedurin@bnl.gov), Prof.  
Dmitry Kayran (dkayran@bnl.gov), Prof. Diktys  
Stratakis (dikty@bnl.gov)  
Brookhaven National Laboratory

<http://www.bnl.gov/atf/>

# Syllabus (plan for spring 2021)



- Course overview, administrative issues.
- Introduction to photo-injectors
- Modeling photo-injectors
- Transport of particle beams, Beam Acceleration
- Beam Diagnostics, emittance measurement techniques
- Dispersion and Masking Techniques
- Computer Lab
- Wakefields and THz generation by corrugated pipe
- Coherent Synchrotron Radiation (CSR). Experimental demonstration of CSR; magnetic bunch compression
- Finishing Simulation in Comp. Lab

PHY542 web page (example):

[http://case.physics.stonybrook.edu/index.php/PHY542\\_spring\\_2019](http://case.physics.stonybrook.edu/index.php/PHY542_spring_2019)

# Evaluation (plan for spring 2021)

- ✓ Student's performance was evaluated based on:
  - ✓ active involvement in the laboratory (25% of final grade);
  - ✓ lab report (60% of final grade);
  - ✓ presentation of a project topic (20% of final grade).
  
- ✓ Students did prepare Report and one Presentation during semester
  - ✓ Report and Presentation from one of lab class (see syllabus)
  - ✓ Content should include: 1) theory of the experiment and explain the objectives; 2) technique used to obtain data; 3) detailed data analysis; 4) conclusion remarks
  
- ✓ Presentation was made at the end of semester. Required better preparation. Presentation was performed at front of the class. To avoid the overlap topics was distributed at beginning of semester among students

PHY542 web page (example):

[http://case.physics.stonybrook.edu/index.php/PHY542\\_spring\\_2019](http://case.physics.stonybrook.edu/index.php/PHY542_spring_2019)

SUPPORTED CODES ▾ PLANS

ELEGANT

WARP VND

SRW

JSPEC

MAD-X

MACHINE LEARNING

OPAL

SHADOW

RADIA

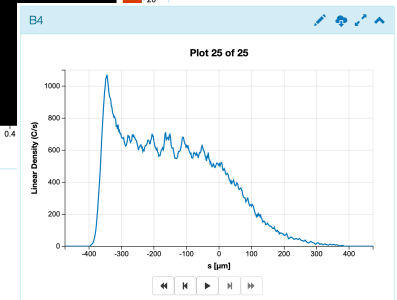
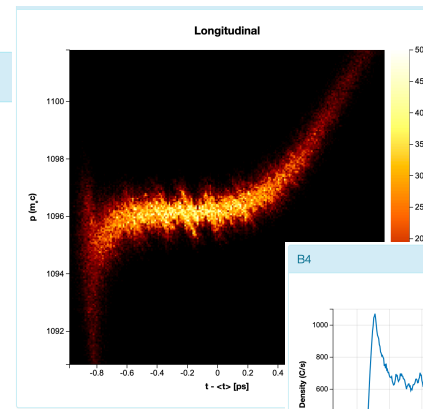
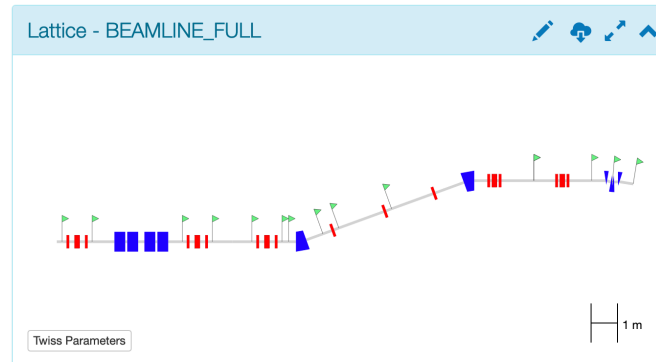
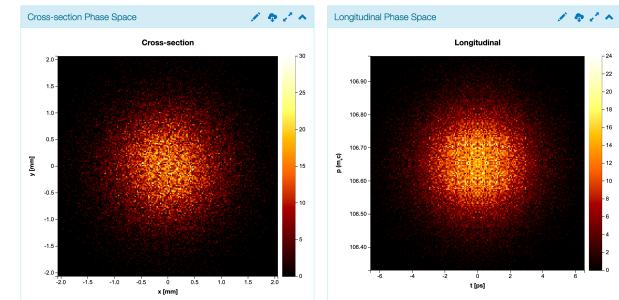
SYNERGIA

WARP PBA

ZGOUBI

# Sirepo for Beam Simulations

- Web browser based
- Free
- Easy to catch
- Amazing visualization



<http://www.sirepo.com/>

# Extended class for City University New York

- In Spring and Fall of 2020 AE63 was extended to give introductory Accelerator Laboratory course for CUNY students
- AE63 extension was supported by BNL diversity program:
  - Round trip travel from NYC to BNL was planned to covered for 18 students
  - 16 hours presentations dedicated accelerator and lase physics by M.Fedurin and M.Polyansky



CUNY  
2019



CUNY 2020 Spring  
on BlueJeans

CUNY 2020 Fall  
on Zoom

**Romario** 4:55 PM

Thank you!

**Brian Park** 4:55 PM

Thank you! It was great presentation

**Leonel Platero** 4:55 PM

thank you!

**Biswajit ramsingh** 4:55 PM

thank you

**Zu Qiang Deng** 4:55 PM

Thank You!!!

**Ralph Castro** 4:55 PM

Thank you for your time

**Jordan Miller** 4:55 PM

Thank you cant wait for the tour and next week 😊

**Caroline Morano** 4:55 PM

# Electron Beam

Parameter	Nominal	Requested
Beam Energy (MeV)	30-65	<i>From 30 MeV to 60 MeV for Linac capability demonstration</i>
Bunch Charge (nC)	0.1-2.0	<i>From 0 to Max at gun (gun demonstration)</i>
Compression	Down to 100 fs (up to 1 kA peak current)	<i>Any compression up to CSR breakup to demonstrate bunch compression principal</i>
Transverse size at IP (sigma, um)	30 – 100 (dependent on IP position)	<i>Any size. Possibility to vary quads in tunnel for emittance measurements.</i>
Normalized Emittance (um)	1 (at 0.3 nC)	<i>Any emittance. Possibility to vary emittance by charge and gun solenoid</i>
Rep. Rate (Hz)	1.5	1.5
Trains mode	Single bunch	<i>Not required</i>

# 2021 Experiment Time Estimates

## **Run Hours (include setup time in hours estimate): 40hrs**

Number of electron beam only hours: 40hrs

Number of CO<sub>2</sub> laser hours delivered to laser experiment hall ("FEL room"): 0

Number of CO<sub>2</sub> laser hours, + ebeam, delivered to electron beam experiment hall: 0

Overall % setup time: 0%

## **Hazards & installation requirements: None**

- 40 hours total of e-beam time distributed over:
  - every Monday from 3pm to 7pm
  - except national holidays, spring break and snow storm impact
- Estimate start date – end of January
- Estimate finish – end of April



# Experimental Time Request

## CY2021 Time Request

Capability	Setup Hours	Running Hours
Electron Beam Only	0	40 (SBU) + 20 (CUNY) in spring + 40 (ECTAST) in summer
Laser* Only (in FEL Room)	0	20 (CUNY)
Laser* + Electron Beam		

## Time Estimate for Remaining Years of Experiment (including CY2021)

Capability	Setup Hours	Running Hours
Electron Beam Only		300
Laser* Only (in FEL Room)		60
Laser* + Electron Beam		

\* Laser = Near-IR or LWIR (CO<sub>2</sub>) Laser

# 2015-2019 Advanced Accelerator Lab students:



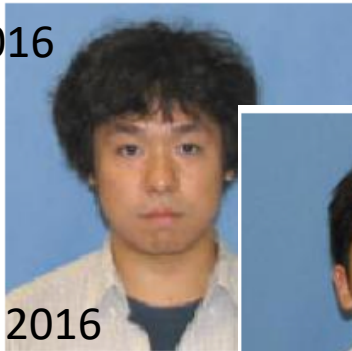
2016



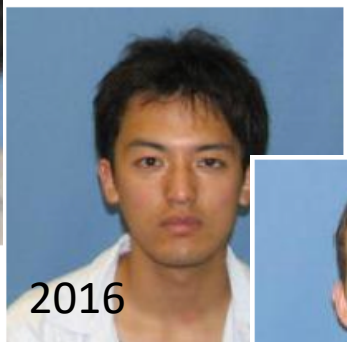
2015



2017



2016



2016



2017



2016



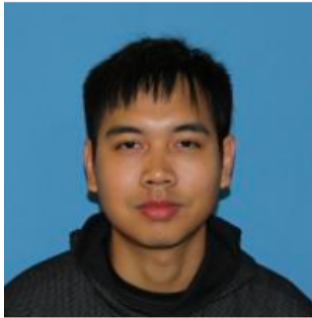
2019



2019



2017



2020



2020

# Support materials

# Ernest Courant Traineeship in Accelerator Science and Technology



Stony Brook Research

myRESEARCH

\$2.9M over 5 years

Collaboration of BNL,  
FNL, Cornell and  
Stony Brook Universities

## Award Letter Received

Grant ID:	FP00002274
PI Name:	Vladimir Litvinenko
Title:	Ernest Courant Traineeship in Accelerator Science and Technology
Sponsor:	US Department of Energy

We would like to inform you that our office has received your award notice referenced below which is being forwarded for processing to your Grants or Contracts Specialist in the Office of Sponsored Programs.

# Accelerator Stewardship program

## Students who worked at ATF (in 2012)

- |     |              |                     |
|-----|--------------|---------------------|
| 1.  | B. Allen     | USC                 |
| 2.  | E. Arab      | UCLA                |
| 3.  | S. Barber    | UCLA                |
| 4.  | K. Boratay   | UT Austin           |
| 5.  | N. Cook      | SUNY SB             |
| 6.  | J. Duris     | UCLA                |
| 7.  | Yu. Fang     | USC                 |
| 8.  | A. Nause     | Tel Aviv University |
| 9.  | B. O'Shea    | UCLA                |
| 10. | F. O'Shea    | UCLA                |
| 11. | A. Ovodenko  | SUNY SB             |
| 12. | L. Shao      | UCLA                |
| 13. | E. Threlkeld | UCLA                |
| 14. | O. Williams  | UCLA                |
| 15. | C. Brenner   | Strathclyde Univ    |
| 16. | D. Carrol    | Strathclyde Univ    |
| 17. | N. Dover     | Imperial college    |
| 18. | A. Flacco    | Ecole Polytechnique |
| 19. | S. Kahalu    | Ecole Polytechnique |
| 20. | C. Palmer    | Imperial college    |
| 21. | M. Streeter  | Imperial college    |
| 22. | F. Sylla     | Ecole Polytechnique |

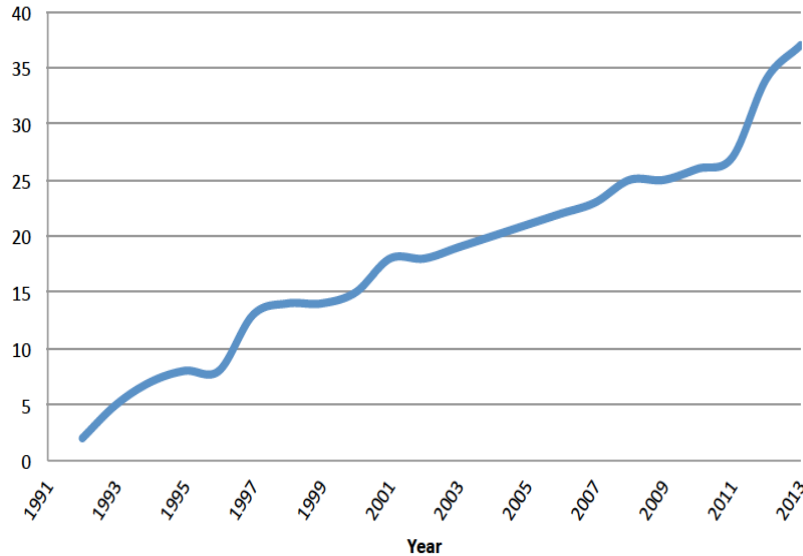
Imperial College  
London



University of  
**Strathclyde**  
Glasgow



Graduating Students (Cumulative)



## The ATF and graduate education

Center for Accelerator Science and Education  
at SUNY SB. Director – Prof. V. Litvinenko

New hands-on graduate course

At the 2013 BNL Young Researcher Symposium, **Nathan Cook**, awarded for his talk, "Impurity Free Ion Beams Accelerated by a 1 TW CO<sub>2</sub> Laser".

nature  
physics

LETTERS

PUBLISHED ONLINE: 14 OCTOBER 2012 | DOI: 10.1038/NPHYS2443

## Beating the shot-noise limit

Avraham Gover<sup>1\*</sup>, Ariel Nause<sup>1</sup>, Egor Dyunin<sup>1</sup> and Mikhail Fedurin<sup>2</sup>

**Ariel Nause**, Tel-Aviv Univ., winner of the 2014 RHIC & AGS Thesis Award for his thesis "Beating the Shot-Noise Limit: Collective Interaction Optical Noise Suppression in Charged Particle Beam".

